Amendments to the Claims

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1. (currently amended) A method of controlling a ~~transducer~~ head velocity during a ramp load/unload comprising ~~the steps of~~:

measuring ~~the~~ voltages across a voice coil motor (VCM) ~~Voice Coil Motor ("VCM")~~ and a sense resistor ~~positioned~~ in series with the VCM, wherein the VCM and sense resistor voltage measurements are calibrated at power-up;

providing multiplexed voltages using the VCM and sense resistor voltages;

calculating a ~~the~~ back EMF ~~emf~~ voltage using the multiplexed ~~measured VCM and sense resistor~~ voltages; and

adjusting the head velocity ~~of the transducer head~~ using the ~~calculated~~ back EMF ~~emf~~ voltage.

2. (cancelled)

3. (currently amended) The method of claim 1 wherein the back EMF ~~emf~~ voltage is calculated using a PWM technique.

4. (currently amended) The method of claim 1 wherein the back EMF ~~emf~~ voltage is calculated using an IR cancellation technique.

5. (cancelled)

6. (currently amended) The method of claim 1 wherein a microprocessor calculates the back EMF ~~emf~~ voltage.

7. (currently amended) The method of claim 6 wherein the microprocessor calculates the back EMF ~~emf~~ voltage using a PWM technique.

8. (currently amended) The method of claim 6 wherein the microprocessor calculates the back EMF ~~emf~~ voltage using an IR cancellation technique.

9. (currently amended) The method of claim 6 wherein the microprocessor calculates the back EMF ~~emf~~ voltage by selecting between ~~using either~~ a PWM technique and ~~or~~ an IR cancellation technique and using the selected technique.

10. (currently amended) The method of claim 6 wherein the microprocessor calculates the back EMF voltage using a calibration constant which is calculated using the VCM and sense resistor voltages while current is applied to the VCM and using the VCM and sense resistor voltages while no current is applied to the VCM~~sends a signal to a control circuit to adjust the velocity of the transducer heads~~.

11. (currently amended) The method of claim 6 ~~10~~ wherein the microprocessor adjusts the head velocity ~~signal is sent~~ in real-time ~~to the control circuit~~.

12-15. (cancelled)

16. (currently amended) A method of controlling a ~~transducer~~ head velocity during a ramp load/unload comprising ~~the steps of~~:

setting a target velocity;

measuring ~~the~~ voltages across a voice coil motor (VCM) ~~("VCM")~~ and a sense resistor in series with the VCM ~~it~~ through separate ~~reference~~ voltage paths;

calculating a back EMF voltage using the ~~measured~~ voltages across the VCM and the sense resistor;

calculating a velocity error using the target velocity and the back EMF voltage;

calculating a control variable using the velocity error;

sending the control variable to a driver that controls the head velocity; and

adjusting the ~~transducer~~ head velocity using the control variable~~velocity error~~.

17. (cancelled)

18. (currently amended) The method of claim 16 further comprising calculating the control variable using a proportional-integral ~~the step of:~~

~~employing the Proportional-Integral~~ control technique.

19-21. (cancelled)

22. (currently amended) The method of claim 16 ~~21~~ wherein the control variable ~~velocity error~~ is calculated in discrete-time.

23. (currently amended) The method of claim 22 further comprising using a ~~comprising:~~

~~setting the~~ velocity error ~~variable~~ for a previous sampling period ~~equal~~ to calculate the velocity ~~voltage~~ error ~~variable~~ for a ~~the~~ current sampling period.

24. (currently amended) The method of claim 23 further comprising using a ~~comprising:~~

~~setting the~~ control variable for the ~~a~~ previous sampling period ~~equal~~ to calculate the control variable for the ~~a~~ current sampling period.

25. (currently amended) The method of claim 16 further comprising ~~the step of:~~

disabling the VCM at ~~the~~ completion of the ramp load/unload.

26. (currently amended) The method of claim 25 further comprising ~~the step of:~~

stopping the control of the ~~transducer~~ head velocity at ~~the~~ completion of the ramp load/unload.

27. (currently amended) A method of measuring a ~~transducer~~ head velocity during a ramp load/unload comprising ~~the steps of~~:

measuring ~~the~~ voltages across a voice coil motor (VCM) ~~("VCM")~~ and a sense resistor in series with the VCM, wherein the VCM and sense resistor voltage measurements are calibrated at power-up;

providing multiplexed voltages using the VCM and sense resistor voltages;

calculating a ~~the~~ back EMF voltage using the multiplexed ~~measured~~ voltages ~~across the VCM and the sense resistor~~; and

calculating the head velocity ~~error~~ using the back EMF voltage.

28. (cancelled)

29. (currently amended) The method of claim 27 further comprising ~~comprising:~~

———using a head velocity for ~~from~~ a previous sampling period to calculate the head ~~determine a~~ velocity for a ~~the~~ current sampling period.

30-32. (cancelled)

33. (currently amended) A disk drive comprising:

a disk;

a head that reads from and writes to the disk;

an actuator assembly that positions the head relative to the disk, wherein the actuator assembly includes an actuator arm and ~~having~~ a voice coil motor (VCM), and the actuator arm is located between the head and the VCM~~that has an internal resistance~~;

a driver ~~circuit~~ for ~~connecting and~~ driving the VCM~~actuator assembly~~;

a sense resistor in series with the VCM~~voice coil motor~~;

a first operational amplifier for amplifying a ~~magnifying the~~ voltage across the VCM ~~resistance~~;

a second operational amplifier for amplifying a ~~magnifying the~~ voltage across the sense resistor; ~~and~~

a multiplexer for multiplexing the amplified voltages; and

a microprocessor for calculating a ~~outputs of the operational amplifiers, whereby~~ back EMF ~~emf~~ voltage ~~is determined~~ based on the multiplexed ~~amplified~~ voltages ~~across the VCM and sense resistor~~.

34. (currently amended) The disk drive of claim 33 wherein the ~~further comprising:~~

~~a~~ microprocessor sends a control ~~for connecting to and sending an input~~ signal based on the back EMF voltage to the driver ~~circuit~~.

35. (currently amended) The disk drive of claim 33 wherein ~~wherein:~~

the microprocessor calculates a ~~the~~ velocity of the VCM based on the back EMF voltage ~~voice coil motor~~ and sends a control signal based on the velocity to the driver ~~circuit~~.

36-37. (cancelled)

38. (currently amended) The disk drive of claim 33 further comprising ~~comprising:~~

———an analog-to-digital converter for converting the multiplexed voltages to a digital signal for ~~form receivable by~~ the microprocessor.

39. (currently amended) The disk drive of claim 38 further comprising a serial port between ~~wherein~~ the analog-to-digital converter and the microprocessor~~uses 12 bits~~.

40. (currently amended) The disk drive of claim 38 further comprising a node connected to the VCM, the sense resistor, a negative input of the first operational amplifier and a positive input of the second operational amplifier~~wherein the analog-to-digital converter has a full-scale voltage of 5 Volts~~.

41. (cancelled)

42. (currently amended) The disk drive of claim 38 ~~33~~ wherein the microprocessor calculates the back EMF ~~emf~~ voltage by selecting between ~~back emf voltage may be calculated using either~~ a PWM technique and ~~or~~ an IR cancellation technique and using the selected technique.

43. (currently amended) A method of controlling a ~~transducer~~ head velocity during a ramp load/unload comprising~~ the steps of~~:

measuring ~~the~~ voltages across a voice coil motor (VCM) ~~Voice Coil Motor ("VCM")~~ and a sense resistor ~~positioned~~ in series with the VCM;

calculating a ~~the~~ back EMF ~~emf~~ voltage using the ~~measured~~ VCM and sense resistor voltages, wherein the back EMF ~~emf~~ voltage is ~~may be~~ calculated using either a PWM technique or an IR cancellation technique, and ~~wherein~~ both techniques are available for calculating the back EMF ~~emf~~ voltage without ~~implementing~~ two distinct sets of hardware; and

adjusting the head velocity ~~of the transducer head~~ using the ~~calculated~~ back EMF ~~emf~~ voltage.

44. (currently amended) A method of controlling a ~~transducer~~ head velocity during a ramp load/unload comprising~~the steps of~~:

measuring ~~the~~ voltages across a voice coil motor (VCM) ~~Voice Coil Motor ("VCM")~~ and a sense resistor ~~positioned~~ in series with the VCM through separate ~~reference~~ voltage paths;

calculating a calibration constant by comparing the VCM voltage with a first reference voltage and comparing the sense resistor voltage with a second reference voltage;

calculating a ~~the~~ back EMF ~~emf~~ voltage using the ~~measured~~ VCM and sense resistor voltages; and

adjusting the head velocity ~~of the transducer head~~ using the ~~calculated~~ back EMF ~~emf~~ voltage.

45. (currently amended) The method of claim 44 further comprising calculating the back EMF voltage using the calibration constant~~the step of applying a current to the VCM to start/stop the movement of the transducer head~~.

46-47. (cancelled)

48. (currently amended) A method of measuring a ~~transducer~~ head velocity during a ramp load/unload comprising~~ the steps of~~:

measuring ~~the~~ voltages across a voice coil motor (VCM) ~~("VCM")~~ and a sense resistor in series with the VCM through separate ~~reference~~ voltage paths;

calculating a calibration constant by comparing the VCM voltage with a first reference voltage and comparing the sense resistor voltage with a second reference voltage;

calculating a ~~the~~ back EMF voltage using the ~~measured~~ voltages across the VCM and the sense resistor; and

calculating the head velocity ~~error~~ using the back EMF voltage.

49-50. (cancelled)

51. (currently amended) The method of claim 48 further comprising calculating the back EMF voltage using the calibration constant~~16 wherein the velocity error is calculated using the target velocity by calculating the velocity of the transducer head in~~

~~discrete time using the measured back emf voltage and comparing the velocity of the transducer head and the target velocity~~.

52. (cancelled)

53. (new) In a disk drive that includes a disk, a head that reads from and writes to the disk, a voice coil motor (VCM) that positions the head relative to the disk, a sense resistor in series with the VCM, and a ramp where the head is parked when the disk is not spinning, a method of operating the disk drive comprising:

measuring a voltage across the VCM;

measuring a voltage across the sense resistor;

generating a first voltage based on the VCM voltage;

generating a second voltage based on the sense resistor voltage;

multiplexing the first and second voltages to provide multiplexed voltages that alternate between the first and second voltages; and

calculating a back EMF voltage of the VCM based on the multiplexed voltages.

54. (new) The method of claim 53 further comprising generating the first voltage by amplifying the VCM voltage and generating the second voltage by amplifying the sense resistor voltage.

55. (new) The method of claim 53 further comprising converting the multiplexed voltages from an analog signal to a digital signal and calculating the back EMF voltage based on the digital signal.

56. (new) The method of claim 53 further comprising calculating the back EMF voltage in discreet-time.

57. (new) The method of claim 53 further comprising calculating the back EMF voltage by selecting between a PWM technique and an IR cancellation technique and using the selected technique, wherein both techniques are available for calculating the back EMF voltage without two distinct sets of hardware.

58. (new) The method of claim 53 further comprising generating the VCM and sense resistor voltages using a driver, generating the first voltage using a first operational amplifier, generating the second voltage using a second operational amplifier, multiplexing the first and second voltages using a multiplexer, digitizing the multiplexed voltages using an analog-to-digital converter and calculating the back EMF voltage using a microprocessor.

59. (new) The method of claim 58 wherein the driver has a first output connected to the VCM and a positive input of the first operational amplifier, the driver has a second output connected to the sense resistor and a negative input of the second operational amplifier, a node is connected to the VCM, the sense resistor, a negative input of the first

operational amplifier and a positive input of the second operational amplifier, the node is connected to the first output of the driver by the VCM and the second output of the driver by the sense resistor, the multiplexer has a first input connected to an output of the first operational amplifier and a second input connected to an output of the second operational amplifier, the analog-to digital converter has an input connected to an output of the multiplexer and an output connected to the microprocessor, and the microprocessor controls the driver and the multiplexer.

60. (new) The method of claim 53 further comprising adjusting a velocity of the head based on the back EMF voltage.

61. (new) The method of claim 60 further comprising performing the method during a ramp load in which the head is moved off the ramp and towards the disk.

62. (new) The method of claim 60 further comprising performing the method during a ramp unload in which the head is moved away from the disk and on the ramp.

63. (new) The method of claim 53 further comprising calculating a calibration constant and calculating the back EMF voltage based on the calibration constant.

64. (new) The method of claim 63 wherein calculating the calibration constant includes:

measuring a reference voltage (Vref1) across the VCM while no current is applied to the VCM;

measuring a reference voltage (Vref2) across the sense resistor while no current is applied to the sense resistor;

measuring another voltage (Vvcm) across the VCM while a current is applied to the VCM;

measuring another voltage (Vrsense) across the sense resistor while a current is applied to the sense resistor; and

calculating the calibration constant (Kcal) according to the equation

$$Kcal = \frac{Vvcm - Vref1}{Vrsense - Vref2}.$$

65. (new) The method of claim 64 further comprising calculating the calibration constant while the head is parked on the ramp.

66. (new) The method of claim 64 further comprising calculating the calibration constant during power-up of the disk drive.

67. (new) The method of claim 64 further comprising calculating the calibration constant only while the head is parked on the ramp during power-up of the disk drive.

68. (new) The method of claim 53 further comprising calculating a control variable based on the back EMF voltage and a target velocity voltage and adjusting a velocity of the head based on the control variable.

69. (new) The method of claim 68 wherein calculating the control variable includes calculating a velocity error as a difference between the back EMF voltage and the target velocity voltage.

70. (new) The method of claim 68 wherein calculating the control variable includes using a proportional-integral control technique.

71. (new) The method of claim 68 wherein calculating the control variable includes measuring the VCM and sense resistor voltages during a current sampling period and using a previous control variable from a previous sampling period.

72. (new) The method of claim 68 wherein calculating the control variable includes using a proportional-integral control technique that measures the VCM and sense resistor voltages during a current sampling period and uses a previous control variable from a previous sampling period.

73. (new) In a disk drive that includes a disk, a head that reads from and writes to the disk, a voice coil motor (VCM) that positions the head relative to the disk, a sense resistor in series with the VCM, a ramp where the head is parked when the disk is not spinning, a driver that drives the VCM, a first operational amplifier, a second operational amplifier, a multiplexer, a digital-to-analog converter and a microprocessor, a method of controlling a velocity of the head comprising:

applying a current across the VCM and the sense resistor to generate voltages across the VCM and the sense resistor using the driver;

generating a first voltage based on the VCM voltage using the first operational amplifier;

generating a second voltage based on the sense resistor voltage using the second operational amplifier;

multiplexing the first and second voltages to provide multiplexed voltages that alternate between the first and second voltages using the multiplexer;

digitizing the multiplexed voltages using the analog-to-digital converter;

calculating a back EMF voltage of the VCM based on the digitized multiplexed voltages using the microprocessor; and

adjusting the head velocity based on the back EMF voltage using the driver.

74. (new) The method of claim 73 further comprising calculating the back EMF voltage by the microprocessor selecting between a PWM technique and an IR cancellation technique and using the selected technique, wherein both techniques are available for calculating the back EMF voltage without two distinct sets of hardware.

75. (new) The method of claim 73 wherein the driver has a first output connected to the VCM and a positive input of the first operational amplifier, the driver has a second output connected to the sense resistor and a negative input of the second operational amplifier, a node is connected to the VCM, the sense resistor, a negative input of the first operational amplifier and a positive input of the second operational amplifier, the node is

connected to the first output of the driver by the VCM and the second output of the driver by the sense resistor, the multiplexer has a first input connected to an output of the first operational amplifier and a second input connected to an output of the second operational amplifier, the analog-to digital converter has an input connected to an output of the multiplexer and an output connected to the microprocessor, and the microprocessor controls the driver and the multiplexer.

76. (new) The method of claim 73 further comprising performing the method during a ramp load in which the head is moved off the ramp and towards the disk.

77. (new) The method of claim 73 further comprising performing the method during a ramp unload in which the head is moved away from the disk and on the ramp.

78. (new) The method of claim 73 further comprising calculating a calibration constant and calculating the back EMF voltage using the calibration constant, wherein calculating the calibration constant includes:

measuring a reference voltage (Vref1) across the VCM while no current is applied to the VCM;

measuring a reference voltage (Vref2) across the sense resistor while no current is applied to the sense resistor;

measuring another voltage (Vvcm) across the VCM while a current is applied to the VCM;

measuring another voltage (Vrsense) across the sense resistor while a current is applied to the sense resistor; and

calculating the calibration constant (Kcal) according to the equation

$$Kcal = \frac{Vvcm - Vref1}{Vrsense - Vref2}.$$

79. (new) The method of claim 78 further comprising calculating the calibration constant only while the head is parked on the ramp during power-up of the disk drive.

80. (new) The method of claim 73 further comprising calculating a control variable using the back EMF voltage and a target velocity voltage and adjusting the head velocity based on the control variable.

81. (new) The method of claim 80 wherein calculating the control variable includes calculating a velocity error as a difference between the back EMF voltage and the target velocity voltage.

82. (new) The method of claim 80 wherein calculating the control variable includes using a proportional-integral control technique that measures the VCM and sense resistor voltages during a current sampling period and uses a previous control variable from a previous sampling period.

83. (new) In a disk drive that includes a disk, a head that reads from and writes to the disk as the head flies above the disk on an air cushion and the disk is spinning, a voice

coil motor (VCM) that positions the head relative to the disk, a sense resistor in series with the VCM, a ramp where the head is parked when the disk is not spinning, a driver that drives the VCM, a first operational amplifier, a second operational amplifier, a multiplexer, a digital-to-analog converter and a microprocessor, a method of controlling a velocity of the head during at least one of (1) a ramp load in which the head is moved off the ramp and towards the disk and (2) a ramp unload in which the head is moved away from the disk and on the ramp, the method comprising:

applying a current across the VCM and the sense resistor to generate voltages across the VCM and the sense resistor using the driver;

generating a first voltage based on the VCM voltage using the first operational amplifier;

generating a second voltage based on the sense resistor voltage using the second operational amplifier;

multiplexing the first and second voltages to provide multiplexed voltages that alternate between the first and second voltages using the multiplexer;

digitizing the multiplexed voltages using the analog-to-digital converter;

calculating a back EMF voltage of the VCM based on the digitized multiplexed voltages using the microprocessor; and

adjusting the head velocity based on the back EMF voltage using the driver.

84. (new) The method of claim 83 further comprising calculating the back EMF voltage by the microprocessor selecting between a PWM technique and an IR

cancellation technique and using the selected technique, wherein both techniques are available for calculating the back EMF voltage without two distinct sets of hardware.

85. (new) The method of claim 83 wherein the driver has a first output connected to the VCM and a positive input of the first operational amplifier, the driver has a second output connected to the sense resistor and a negative input of the second operational amplifier, a node is connected to the VCM, the sense resistor, a negative input of the first operational amplifier and a positive input of the second operational amplifier, the node is connected to the first output of the driver by the VCM and the second output of the driver by the sense resistor, the multiplexer has a first input connected to an output of the first operational amplifier and a second input connected to an output of the second operational amplifier, the analog-to digital converter has an input connected to an output of the multiplexer and an output connected to the microprocessor, and the microprocessor controls the driver and the multiplexer.

86. (new) The method of claim 83 further comprising performing the method during the ramp load.

87. (new) The method of claim 83 further comprising performing the method during the ramp unload.

88. (new) The method of claim 83 further comprising calculating a calibration constant and calculating the back EMF voltage using the calibration constant, wherein calculating the calibration constant includes:

measuring a reference voltage (Vref1) across the VCM while no current is applied to the VCM;

measuring a reference voltage (Vref2) across the sense resistor while no current is applied to the sense resistor;

measuring another voltage (Vvcm) across the VCM while a current is applied to the VCM;

measuring another voltage (Vrsense) across the sense resistor while a current is applied to the sense resistor; and

calculating the calibration constant (Kcal) according to the equation

$$Kcal = \frac{Vvcm - Vref1}{Vrsense - Vref2}.$$

89. (new) The method of claim 88 further comprising calculating the calibration constant only while the head is parked on the ramp during power-up of the disk drive.

90. (new) The method of claim 83 further comprising calculating a control variable using the back EMF voltage and a target velocity voltage and adjusting the head velocity based on the control variable.

91. (new) The method of claim 90 wherein calculating the control variable includes calculating a velocity error as a difference between the back EMF voltage and the target velocity voltage.

92. (new) The method of claim 90 wherein calculating the control variable includes using a proportional-integral control technique that measures the VCM and sense resistor voltages during a current sampling period and uses a previous control variable from a previous sampling period.